1. Transl Vis Sci Technol. 2019 Dec 5;8(6):26. doi: 10.1167/tvst.8.6.26. eCollection

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OCTA-Based Identification of Different Vascular Patterns in Stargardt Disease.

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Purpose: The aim of the present study was to analyze quantitative optical

coherence tomography (OCT) and OCT angiography (OCTA) parameters to identify

clinically relevant cutoff values able to detect clinically different Stargardt's

disease (STGD) subgroups.

Methods: Consecutive STGD patients were recruited and underwent complete

ophthalmologic examination, including multimodal imaging. Several quantitative

parameters were extracted both from structural OCT and OCTA images and were

statistically analyzed. A post hoc analysis was performed to identify a

quantitative cutoff able to distinguish two clinically different STGD subgroups.

Main outcome measures were total retinal thickness, central macular thickness

(CMT), retinal layers thickness, retinal and choroidal hyperreflective foci (HF)

number, vessel density (VD), vessel tortuosity (VT), vessel dispersion (Vdisp),

and vessel rarefaction (VR) of macular and optic nerve head plexa.

Results: Overall, 54 eyes of 54 STGD patients (18 males) and 54 eyes of 54

healthy age- and sex-matched controls were included in the analysis. All

quantitative parameters resulted significantly worse in STGD than controls (P <

0.01). Moreover, a VT cutoff of 5 allowed to distinguish the following two

categories: a functionally and anatomically better STGD group and a worse group.

BCVA resulted 0.42 ± 0.28 logMAR in the best group versus 1.09 ± 0.36 logMAR in

the worst (P < 0.01). Structural OCT and OCTA parameters significantly differed

between the two STGD groups.

Conclusions: Quantitative OCTA was able to detect different morphofunctional STGD

phenotypes.

Translational Relevance: OCTA-based classification of STGD patients detected

different patients' subgroups, differing in terms of morphologic and functional

features, with a potential impact on clinical and research settings.

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2.

A novel computer-aided diagnosis system for the early detection of hypertension

based on cerebrovascular alterations.

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Hypertension is a leading cause of mortality in the USA. While simple tools such

as the sphygmomanometer are widely used to diagnose hypertension, they could not

predict the disease before its onset. Clinical studies suggest that alterations

in the structure of human brains' cerebrovasculature start to develop years

before the onset of hypertension. In this research, we present a novel

computer-aided diagnosis (CAD) system for the early detection of hypertension.

The proposed CAD system analyzes magnetic resonance angiography (MRA) data of

human brains to detect and track the cerebral vascular alterations and this is

achieved using the following steps: i) MRA data are preprocessed to eliminate

noise effects, correct the bias field effect, reduce the contrast inhomogeneity

using the generalized Gauss-Markov random field (GGMRF) model, and normalize the

MRA data, ii) the cerebral vascular tree of each MRA volume is segmented using a

3-D convolutional neural network (3D-CNN), iii) cerebral features in terms of

diameters and tortuosity of blood vessels are estimated and used to construct

feature vectors, iv) feature vectors are then used to train and test various

artificial neural networks to classify data into two classes; normal and

hypertensive. A balanced data set of 66 subjects were used to test the CAD

system. Experimental results reported a classification accuracy of 90.9% which

supports the efficacy of the CAD system components to accurately model and

discriminate between normal and hypertensive subjects. Clinicians would benefit

from the proposed CAD system to detect and track cerebral vascular alterations

over time for people with high potential of developing hypertension and to

prepare appropriate treatment plans to mitigate adverse events.

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Supervised Machine Learning Based Multi-Task Artificial Intelligence

Classification of Retinopathies.

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Artificial intelligence (AI) classification holds promise as a novel and

affordable screening tool for clinical management of ocular diseases. Rural and

underserved areas, which suffer from lack of access to experienced

ophthalmologists may particularly benefit from this technology. Quantitative

optical coherence tomography angiography (OCTA) imaging provides excellent

capability to identify subtle vascular distortions, which are useful for

classifying retinovascular diseases. However, application of AI for

differentiation and classification of multiple eye diseases is not yet

established. In this study, we demonstrate supervised machine learning based

multi-task OCTA classification. We sought 1) to differentiate normal from

diseased ocular conditions, 2) to differentiate different ocular disease

conditions from each other, and 3) to stage the severity of each ocular

condition. Quantitative OCTA features, including blood vessel tortuosity (BVT),

blood vascular caliber (BVC), vessel perimeter index (VPI), blood vessel density

(BVD), foveal avascular zone (FAZ) area (FAZ-A), and FAZ contour irregularity

(FAZ-CI) were fully automatically extracted from the OCTA images. A stepwise

backward elimination approach was employed to identify sensitive OCTA features

and optimal-feature-combinations for the multi-task classification. For

proof-of-concept demonstration, diabetic retinopathy (DR) and sickle cell

retinopathy (SCR) were used to validate the supervised machine leaning

classifier. The presented AI classification methodology is applicable and can be

readily extended to other ocular diseases, holding promise to enable a

mass-screening platform for clinical deployment and telemedicine.

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J. I. Lim. No other competing interest for any other authors.

4. BMC Med Res Methodol. 2018 Nov 20;18(1):144. doi: 10.1186/s12874-018-0598-3.

Retinal vascular tortuosity assessment: inter-intra expert analysis and

correlation with computational measurements.

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BACKGROUND: The retinal vascular tortuosity can be a potential indicator of

relevant vascular and non-vascular diseases. However, the lack of a precise and

standard guide for the tortuosity evaluation hinders its use for diagnostic and

treatment purposes. This work aims to advance in the standardization of the

retinal vascular tortuosity as a clinical biomarker with diagnostic potential,

allowing, thereby, the validation of objective computational measurements on the

basis of the entire spectrum of the expert knowledge.

METHODS: This paper describes a multi-expert validation process of the

computational vascular tortuosity measurements of reference. A group of five

experts, covering the different clinical profiles of an ophthalmological service,

and a four-grade scale from non-tortuous to severe tortuosity as well as

non-tortuous / tortuous and asymptomatic / symptomatic binary classifications are

considered for the analysis of the the multi-expert validation procedure. The

specialists rating process comprises two rounds involving all the experts and a

joint round to establish consensual rates. The expert agreement is analyzed

throughout the rating procedure and, then, the consensual rates are set as the

reference to validate the prognostic performance of four computational tortuosity

metrics of reference.

RESULTS: The Kappa indexes for the intra-rater agreement analysis were obtained

between 0.35 and 0.83 whereas for the inter-rater agreement in the asymptomatic /

symptomatic classification were between 0.22 and 0.76. The Area Under the Curve

(AUC) for each expert against the consensual rates were placed between 0.61 and

0.83 whereas the prognostic performance of the best objective tortuosity metric

was 0.80.

CONCLUSIONS: There is a high inter and intra-rater variability, especially for

the case of the four grade scale. The prognostic performance of the tortuosity

measurements is close to the experts' performance, especially for Grisan

measurement. However, there is a gap between the automatic effectiveness and the

expert perception given the lack of clinical criteria in the computational

measurements.

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5. Exp Eye Res. 2013 Jan;106:40-6. doi: 10.1016/j.exer.2012.10.015. Epub 2012 Nov 9.

Retinal vessel tortuosity measures and their applications.

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Structural retinal vascular characteristics, such as vessel calibers, tortuosity

and bifurcation angles are increasingly quantified in an objective manner, slowly

replacing subjective qualitative disease classification schemes. This paper

provides an overview of the current methodologies and calculations used to

compute retinal vessel tortuosity. We set out the different parameter

calculations and provide an insight into the clinical applications, while

critically reviewing its pitfalls and shortcomings.

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6. J AAPOS. 2012 Jun;16(3):223-8. doi: 10.1016/j.jaapos.2011.11.015.

Digital image analysis in retinopathy of prematurity: a comparison of vessel

selection methods.

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PURPOSE: To evaluate vessel selection methods to distinguish between eyes with

and without retinopathy of prematurity (ROP) and between different stages of ROP

when quantifying the associated vessel changes in width and tortuosity

semiautomatically from digital retinal images.

METHODS: Color digital images from 75 infants screened for ROP were cropped to a

standardized diameter of 240 pixels and evaluated by semiautomated vessel

analysis software, Computer-Aided Image Analysis of the Retina (CAIAR), to

measure retinal vessel width and tortuosity. Two methods of vessel selection were

used: (1) clinical observer selecting the most prominent arteriole or venule in

each retinal quadrant (4-vessel analysis) and then separately the 4 most

prominent arterioles and venules from each quadrant (8-vessel analysis); (2)

CAIAR selecting, regardless of retinal quadrant, the 4 widest or most tortuous

arterioles or venules. Selected vessels were measured by CAIAR for tortuosity and

width.

RESULTS: When comparing ROP stages, whether observer or CAIAR selected and

whether 4 or 8 vessels were analyzed, we found that arteriolar tortuosity was

significantly greater with advancing ROP stage for stage 0 versus stage 2; stage

0 or 1 versus stage 3; stages 1+2 combined versus stage 3; and stage 0 versus

1+2+3 combined (P < 0.01). Venular tortuosity was significantly greater with

advancing ROP stage for stage 0 versus stage 3 and stage 0 versus stages 1 and

2+3 combined (P < 0.01). Width parameters did not help us to distinguish between

stages.

CONCLUSIONS: Distinguishing between arterioles and venules is not necessary to

differentiate stage 0 ROP from stage 2 or 3 ROP when one is using CAIAR.

Tortuosity shows more promise than width at providing a reliable vessel parameter

for distinguishing between eyes without and with ROP.

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